

Grape (Table)

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Scientific Name and Introduction: The table grape (*Vitis vinifera* L.) is a non-climacteric fruit with a relatively low rate of physiological activity, is subject to serious water loss following harvest, which can result in stem drying and browning, berry shatter, and even wilting and shriveling of berries. Gray mold, caused by the fungus *Botrytis cinerea*, requires constant attention and treatment during storage and handling. In California, the major cultivars are 'Thompson Seedless' (Sultanina) and 'Flame Seedless' marketed mostly during the Summer months up to 8 to 10 weeks after harvest. Present interest centers on other introduced seedless 'Fantasy' cultivars such as Ruby Seedless and Crimson. Seeded 'Red Globe' is becoming important late in the season.

Quality Characteristics and Criteria: High consumer acceptance is attained for fruit with high SSC or a high ratio of SSC to TA, ie., SSC/TA ratio. Berry firmness is also an important factor for consumer acceptance as are lack of defects such as decay, cracked berries, stem browning, shriveling, sunburned, dried berries, and insect damage.

Horticultural Maturity Indices: In California, harvest date is determined by SSC of 14 to 17.5% depending on cultivar and production area. In early production areas, an SSC/TA ratio of 20 or higher is used to determine minimum maturity for cultivars that meet a low minimum SSC. For red and black colored cultivars, there is also a minimum color requirement.

Grades, Sizes and Packaging: Most California table grapes are packed in the field. In contrast to South Africa and Chile, few grapes are shed packed. The most common field-packing system is the "avenue pack." Fruit are picked and placed into picking lugs. Usually, the picker also trims the cluster. The picking lug is then transferred a short distance to the packer, who works at a small and shape portable stand in the avenue between vineyard blocks.

Shed-packed fruit is harvested by pickers and placed in field lugs without trimming. Then placed in the shade of the vines to await transport to the shed. At the packing shed the field lugs are distributed to packers who select, trim, and pack the fruit. Often two different grades are packed simultaneously by each packer to facilitate quality selection. In some operations, trimming, color sorting, and a first quality sorting may occur in the field. In all of the systems, grapes are nearly always packed on a scale to facilitate packing to a precise net weight, whether field or shed packed. In general mid and late season grapes are packed in plastic bags or wrapped in paper. For early season grapes, bulk pack is mainly used. In all cases, packed lugs are subject to quality inspection and check weighing.

After packing and lidding, grapes are palletized on disposable or recycled pallets. Some strapping in the field before loading is necessary in grapes packed in shoebox boxes. Often loaded pallets coming from the field pass through a "pallet squeeze," a device that straightens and tightens the stacks of containers. These pallet loads are unitized, usually by strapping or netting. Some palletizing glue is used in shedpacking operations. This glue bonds the corrugated containers vertically on the pallet so that only horizontal strapping is required.

Pre-cooling Conditions: Cooling must start as soon as possible and SO₂ applied within 12 h of harvest. Many forced-air coolers for grapes in California are designed to achieve 7/8 cooling in 6 h or less. After cooling is complete, pallets are moved to a storage room to await transport.

Optimum Storage Conditions: Ideally, storage rooms should operate at -1 to 0 °C (30 to 32 °F) with 90 to 95% RH, and a moderate airflow of 20 to 40 ft³ min⁻¹ ton⁻¹ of stored grapes. The constant low temperature, high RH and moderate airflow are important to limit water loss from fruit stems. Fruit should be stored at a pulp temperature of -0.5 to 0 °C (31 to 32 °C) throughout their postharvest life.

Optimum Temperature: A storage temperature of -1 to 0 °C (30 to 32 °F) is recommended for mature fruit. Freezing damage may occur in less mature grapes. The highest freezing point for berries is -3.0 °C (26.6 °F), but the freezing point varies depending on SSC. A -2 °C (28.4 °F) freezing point for stems has been reported for wine grapes. New table grape cultivars are more sensitive to stem freezing damage. A RH of 90 to 95% and an air velocity of approximately 20 to 40 ft³ min⁻¹ is suggested during storage.

Controlled Atmosphere (CA) Considerations: CA of 2 to 5% O₂ + 1 to 5% CO₂ during storage/shipment is not currently recommended for table grapes because it is only slightly beneficial. SO₂ is used for decay control. CO₂ at 10 to 15% in air can be used to control grey mold for 2 to 4 weeks depending on cultivar.

Retail Outlet Display Considerations: Use of a cold table for display is recommended.

Chilling Sensitivity: Table grapes are not chilling sensitive.

Rates of Ethylene Production and Sensitivity: Table grapes produce < 0.1 µL kg⁻¹ h⁻¹ at 20 °C (68 °F). They are not very sensitive to ethylene.

Respiration Rates: (grape clusters, ie., berries + stems)

Temperature	mg CO ₂ kg ⁻¹ h ⁻¹
0 °C	2 to 4
5 °C	6 to 8
10 °C	10 to 16
20 °C	24 to 30

Stem respiration is approximately 15-fold higher than berry respiration. To get mL kg⁻¹ h⁻¹, divide the mg kg⁻¹ h⁻¹ rate by 2.0 at 0 °C (32 °F), 1.9 at 10 °C (50 °F), and 1.8 at 20 °C (68 °F). To calculate heat production, multiply mg kg⁻¹ h⁻¹ by 220 to get BTU per ton per day or by 61 to get kcal per metric ton per day.

Physiological Disorders: Shatter is a loss of berries from the cap stem. In general, shatter increases in severity with increasing maturity, ie., the longer fruit remain on the vine. Berries of seedless cultivars are usually less well attached to the cap stem than seeded cultivars. Shatter varies considerably from season to season, and there is a large variation among varieties. Gibberellin applied at fruit set weakens berry attachment. Shatter is mainly due to rough handling during field packing with additional shatter occurring all the way to final retail sale. Shatter incidence can be reduced by controlling pack depth and packing density (in³ lb⁻¹), using cluster bagging, gentle handling, and maintaining recommended temperature and RH. Cane girdling reduces shattering incidence.

Waterberry is associated with fruit ripening and most often begins to develop shortly after veraison (berry softening). The earliest symptom is the development of small (1 to 2 mm) dark spots on the cap stems (pedicles) and/or other parts of the cluster framework. These spots become necrotic, slightly sunken, and expand to affect more areas. The affected berries become watery, soft, and flabby when ripe. In California, this disorder has been associated with a high nitrogen status vine, canopy shading, or cool weather during veraison and fruit ripening. Avoid over-fertilization with nitrogen. Foliar nutrient sprays of nitrogen should be avoided in waterberry-prone vineyards. Removing affected berries during harvest and packing is a common practice, although labor intensive.

Postharvest Pathology: Gray mold (*Botrytis cinerea*) is the most destructive of the postharvest diseases of table grapes, primarily because it develops at temperatures as low as 31 °F (-0.5 °C) and grows from berry to berry. Gray mold first turns berries brown, then loosens the skin of the berry, its white, thread-like hyphal filaments erupt through the berry surface, and finally masses of gray colored spores develop. Wounds on the berry surface near harvest provide opportunities for infection, although no wound is required for infection when wet conditions occur. Removing desiccated, infected grapes from the previous season can reduce Gray Mold infection. Leaf-removal canopy management, pre-harvest fungicides, trimming visibly infected, split, cracked, or otherwise damaged grapes before packing is recommended. Prompt cooling and fumigation with SO₂ (100 µL L⁻¹ for 1 h is essential to control gray mold during cold storage). Because of increased interest in the export market, there is a need to use SO₂ generating pads, especially for long-distance export marketing where grapes are in ocean transport for extended periods. These pads have sodium metabisulfite incorporated into them that releases SO₂ during transit and marketing.

Other pathogens become important at warmer temperatures, and they appear commonly sometime during transport or marketing after grapes are removed from cold storage. Black rot, caused by *Aspergillus niger*, blue rot, caused by *Penicillium* spp., and rhizopus rot, caused by *Rhizopus stolonifer* or *R. oryzae*. They are at least partially controlled by SO₂ fumigation, although little research has been done to show this (Snowdon, 1990).

Sulfur Dioxide Use: Botrytis rot of grapes is not sufficiently avoided by fast cooling alone. It is standard practice in California to fumigate with SO₂ immediately after packing followed by lower dose treatments weekly during storage. Formulas for calculating initial and subsequent weekly SO₂ fumigation dosages using the traditional system are available (Harvest and Handling California Table Grapes for Market, Bulletin 1913, 1986; University of California DANR Bulletin 1932). Recently it has been demonstrated that the amount of SO₂ gas needed to kill *Botrytis* spores, or to inactivate exposed mycelium is dependent on the concentration and the length of time the fungus is exposed to the fumigant. A cumulative concentration, calculated as the product of concentration and time, called "CT product," describes the SO₂ exposure needed to kill the decay organism. A CT of at least 100 µL L⁻¹ h⁻¹ is the minimum required to kill spores and mycelium of *Botrytis* at 0 °C (32 °F). This finding was the basis for the development of the total utilization system. Total utilization often uses about half as much SO₂ as the traditional method and improves uniformity and effectiveness of SO₂ fumigant. In this total utilization system, the first fumigation is done in conjunction with forced-air cooling. The forced-air flows through boxes and ensures good penetration of SO₂ even to the center boxes on a pallet. In most combinations of boxes and packs, this system produces over 80% penetration, measured as percent of the room air CT product. Storage fumigation is done every 7 to 10 days. Details on this work are contained in the above cited University of California DANR Bulletin 1932.

During ocean shipment for periods > 10 days or long retail handling in which SO₂ fumigation cannot be applied, the use of SO₂-generating pads in combination with a box liner is advised. These SO₂-generating pads have sodium metabisulfite incorporated into them to allow a constant and slow release of SO₂ during shipment and marketing. In California, the slow-release SO₂ generating pad used combined to a perforated polyethylene box liner with 1/4 in (6 mm) holes at 3 to 4 in (7.6 to 10.2 cm) center, reduces water loss and assures gray mold control without enhancing SO₂ phytotoxicity (Crisosto et al., 1994).

Quarantine Issues: Issues associated with exotic pest quarantines, either addressing imported or exported table grapes, can change rapidly. Rules regarding import requirements are issued by APHIS. This agency provides information to assist exporters in targeting markets and defining what entry requirements a particular country might have for table grapes. APHIS, in cooperation with State plant boards, developed a data base, called "Excerpt," to track the phytosanitary requirements for each country. APHIS also provides phytosanitary inspections and certifications that declare grapes are free of pests to facilitate

compliance with foreign regulatory requirements.

Grapes imported into the U.S. are fumigated with methyl bromide, following treatment schedules issued by APHIS, to prevent entry of insect pests. Cold treatments are also accepted by APHIS for the control of fruit flies. Of primary concern are the vine moth, *Lobesia botrana*, the Mediterranean fruit fly, *Ceratitis capitata*, and miscellaneous external feeding insects.

Grapes exported from the U.S. may harbor pests of concern elsewhere, but they rarely require treatment, although this situation can change rapidly. Black widow spiders are occasional hitchhikers within grape clusters or within grape boxes; SO₂ fumigation, alone or combined with CO₂, has been used successfully to kill spiders before export. Omnivorous leafroller, *Platnota stultana*, is found on grapes in California and has the potential to be a pest of regulatory concern on table grapes exported to counties where this pest is not found. Two methods of control are insecticidal CA treatment (Ahumada et al., 1996) and low temperature storage combined with SO₂ slow-release generators (Yokoyama et al., 1999).

Suitability as Fresh-cut Product: Grapes are well adapted to a stem-less packaging system.

Special Considerations: Market life varies among table grape cultivars grown in California and is also strongly affected by temperature management and decay susceptibility.

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